PB-239 657

ESTES LAKE, YORK COUNTY, MAINE

Pacific Northwest Environmental Research Laboratory

Prepared for:

National Environmental Research Center
Maine National Guard
Maine Department of Environmental Protection

May 1974

DISTRIBUTED BY:

NTIS
National Technical Information Service
U. S. DEPARTMENT OF COMMERCE

TECHNICAL REPORT DATA (Please read Instructions on the reverse before completing)		
1. REPORT NO.	2.	3. PB 239 657
4. TITLE AND SUBTITLE Report on Estes Lake, York County, Maine		5. REPORT DATE Prepared May 1974 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Anonymous (National Eutrophication Survey Staff)		8. PERFORMING ORGANIZATION REPORT NO. Working Paper # 3
9. PERFORMING ORGANIZATION NAME AND ADDRESS Pacific Northwest Environmental Research Laboratory U.S.Environmental Protection Agency 200 S. W. 35th St. Corvallis, Oregon 97330		10. PROGRAM ELEMENT NO. 1BA029 11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS U.S. Environmental Protection Agency		13. TYPE OF REPORT AND PERIOD COVERED Final - 1972 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

Prepared in cooperation with the U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada 89114

16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivded according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
US Department of Commerce
Springfield, VA. 22151

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
eutrophication lakes nutrients phosphorus nitrogen loading		05B 05C

PRICES SUBJECT TO CHANGE

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS (This Report)	21. NO. OF PAGES
Release unlimited		39
	20. SECURITY CLASS (This page)	22. PRICE 3.75-2.25

REPORT
ON
ESTES LAKE
YORK COUNTY
MAINE

EPA REGION I

WORKING PAPER NO. 3

WITH THE COOPERATION OF THE

MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

AND THE

MAINE NATIONAL GUARD

MAY, 1974

CONTENTS

	Page
Foreword	ii
List of Maine Study Lakes	iv
Lake and Drainage Area Map	v
Sections	
I. Conclusions	1
II. Introduction	2
III. Lake and Drainage Basin Characteristics	4
IV. Lake Water Quality Summary	5
V. Nutrient Loadings	10
VI. Literature Reviewed	16
VII. Appendices	17

FOREWORD

The National Eutrophication Survey was initiated in 1972 as a research project in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations and impact on selected fresh water lakes as a basis for formulating comprehensive and coordinated national, regional and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations and impacts can, in fact, be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

This report documents the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin. It is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/ standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Maine Department of Environmental Protection for professional involvement and to the Maine National Guard for conduct of the tributary sampling phase of the Survey.

William R. Adams, Commissioner of the Department of Environmental Protection, and William P. Hinckley and Matthew Scott of the Division of Lakes and Biological Studies, provided invaluable lake documentation and counsel during the course of the study.

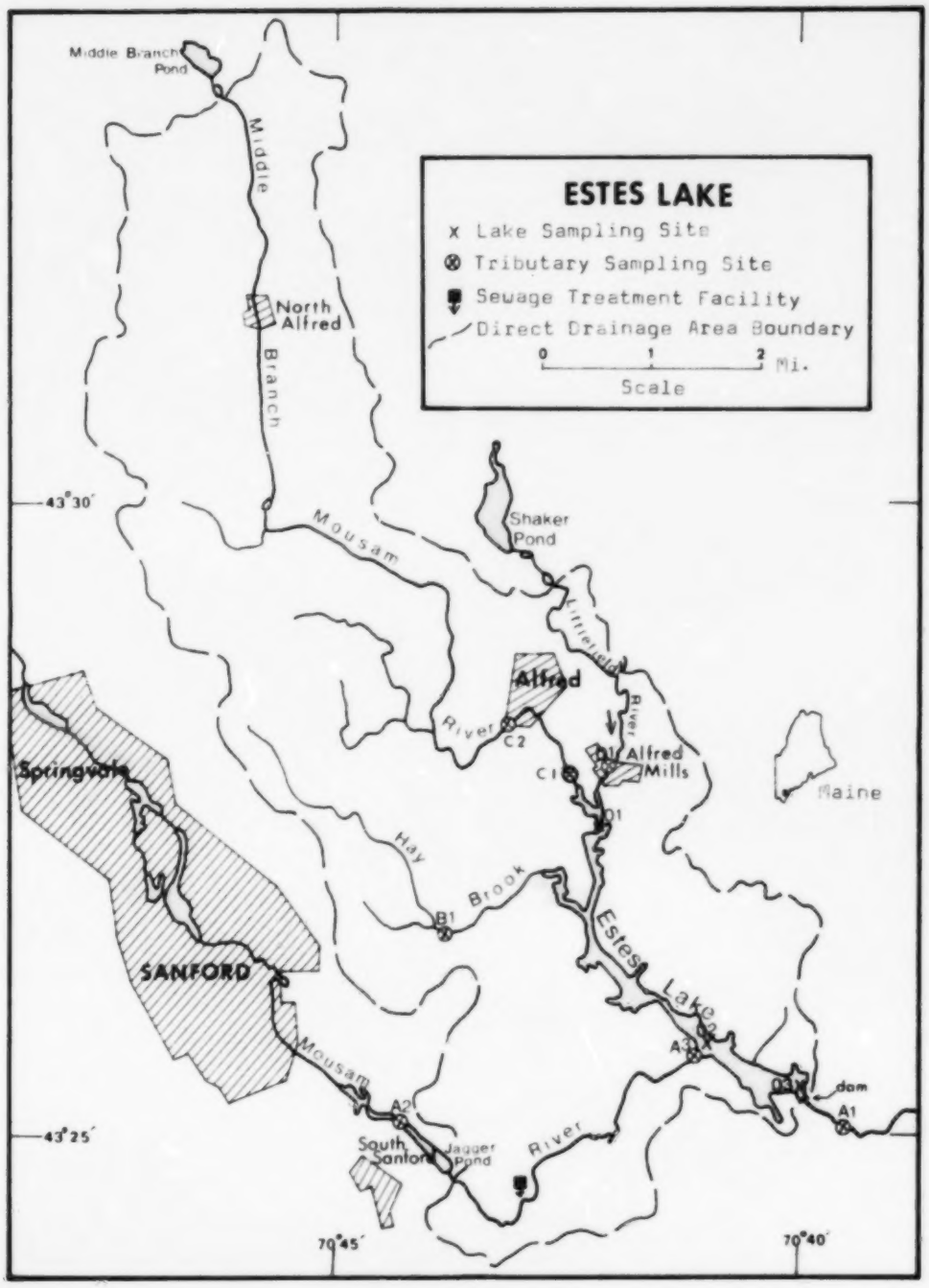
Major General Edwin W. Heywood (Retired), then the Adjutant General of Maine, and Project Officer Lieutenant Colonel Earl B. Adams who directed the volunteer efforts of the forty-one participating Maine National Guardsmen are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF MAINE

LAKE NAME	COUNTY
Moosehead Lake	Piscataquis, Somerset
Estes Lake	York
Long Lake	Cumberland
Bay of Naples & Sebago Lake	Cumberland
Rangeley Lake	Franklin
Long Lake	Aroostook
Mattawamkeag Lake	Aroostook
Sebasticook Lake	Penobscot


ESTES LAKE
x Lake Sampling Site
⊗ Tributary Sampling Site
Sewage Treatment Facility
Direct Drainage Area Boundary
0 1 2 Mi.
Scale
Middle Branch Pond
Middle Branch
North Alfred
Mousam
Shaker Pond
Littlefield
Alfred
River
C2
C1
Alfred Mills
Springvale
Maine
D1
Hay Brook
B1
Estes Lake
SANFORD
Mousam
A3
dam
A2
A1
South Sanford
Jagger Pond
River
43°30'
43°25'
70°45'
70°40'

ESTES LAKE

STORET NO. 2304

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate Estes Lake is eutrophic. Chlorophyll a values were extremely high, Secchi disc values were low, and nutrient concentrations in the lake were rather high.

Data obtained in a 1954 study indicate Estes Lake was free of aquatic nuisance conditions at that time. More recent studies show Estes Lake experiencing frequent and heavy blooms of nuisance algae, excessive growth of aquatic weeds, and depletion of dissolved oxygen in the deeper areas of the lake.

B. Rate-Limiting Nutrient:

Algal assay results show that Estes Lake was nitrogen limited at the time the sample was collected. The lake data indicate nitrogen limitation for the other sampling periods as well.

C. Nutrient Sources; Controllability:

1. Point Sources - During the Survey year, the Sanford waste treatment facility contributed about 74% of the total phosphorus loading to Estes Lake. High level reduction of phosphorus from this source should result in somewhat improved lake water quality.

2. Non-Point Sources - Nitrogen loading from diffuse sources is calculated to be nearly 75% of the total, while only one-fourth of the total phosphorus is contributed from these sources. Because non-point phosphorus loading alone exceeds the predicted "permissible" level of Vollenweider, reduction of areal contributions could also be expected to yield improved water quality.

II. INTRODUCTION

Estes Lake is an impoundment; and, as such, it is not typical of the nearly 3,000 natural lakes and ponds in Maine. The lake was formed by the construction of a 20-foot-head power dam on the Mousam River in the southwestern part of the State. At present, the small hydroelectric plant served by the impoundment operates only periodically and infrequently. The primary use of the lake now is for irrigation, and recreational uses are limited. The direct drainage area is estimated to be 25% urban, 30% agricultural, and 45% woodland and non-agricultural.

In August, 1954, the Maine Department of Inland Fisheries and Game conducted a biological survey of Estes Lake as part of the Mousam River Fish Restoration Survey. At that time, the waters of Estes Lake were described as light brown in color with no algal blooms or abundant growths of aquatic plants, and conditions favored recreational uses; Estes Lake was considered suitable for warm-water fishery management.

The Sanford Sewerage District wastewater treatment facilities became operational in 1962, and in August of 1967, personnel of the Maine Department of Inland Fisheries and Game conducted another biological survey. In the report on that survey, Estes Lake was depicted as quite different than described in the 1954 report. Phytoplankton blooms were reported as quite heavy (turning the water "bright green"), and heavy growths of the aquatic plant Lemna sp. (considered an indication of high enrichment)

were present in most areas of the lake. The report, along with a reported fish kill in 1963, indicated Estes Lake was exhibiting the effects of cultural eutrophication.

In the summer and fall of 1971, a water quality study was conducted on Estes Lake and its tributaries by Dr. Robert Ciullo of the Biology Department of Nasson College, Springvale, Maine. Dr. Ciullo also indicated Estes Lake was exhibiting effects of cultural eutrophication; i.e., plankton blooms were present, aquatic weed growths were heavy, Secchi disc readings were poor, and the levels of nutrients entering Estes Lake were quite high.

It appears that the trophic condition of Estes Lake has changed markedly in the last two decades.

III. LAKE AND DRAINAGE BASIN CHARACTERISTICS

A. Lake Morphometry:

1. Surface area: 387 acres
2. Mean depth: 10 feet
3. Maximum depth: 30 feet
4. Volume: 3,870 acre/ft
5. Mean hydraulic retention time: 11 days

B. Tributary and Outlet:

(See Appendix A for flow data; also see page 15)

1. Tributaries -

Name	Drainage area†	Mean flow†
Mousam River	50.5 mi^2	85.3 cfs
Hay Brook	2.8 mi^2	4.7 cfs
Middle Br., Mousam River	16.8 mi^2	28.4 cfs
Littlefield River	24.6 mi^2	41.6 cfs
Minor tributaries & immediate drainage -	9.7 mi^2	17.4 cfs
Totals	104.4 mi^2	177.4 cfs

2. Outlet -

Mousam River	105.0 mi^2*	177.4 cfs

C. Precipitation**:

1. Year of sampling: 53.7 inches.
2. Mean annual: 39.2 inches.

---

* Includes area of lake.
** See Working Paper No. 1, "Survey Methods".
† Drainage areas are accurate within ±1% and mean annual flows within ±5%.

IV. LAKE WATER QUALITY SUMMARY

Estes Lake was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from three stations on the lake and from a number of depths at each station (see map, page v). During each visit a single depth-integrated (near bottom to surface) sample was composited from the three stations for phytoplankton identification and enumeration; and during the last visit, a single five-gallon depth-integrated sample was composited for algal assays. Also, each time depth-integrated samples were collected at the stations for chlorophyll *a* analyses. Maximum depths sampled were 15 feet at station 1, 16 feet at station 2, and 4 feet at station 3.

The results obtained are presented in full in Appendix B, and the data for the fall sampling period, when the lake was essentially well-mixed, are summarized below. Note, however, the Secchi disc summary is based on all samples.

For the differences in the various parameters at the other sampling times, refer to Appendix B.

A. Physical and chemical characteristics:

FALL VALUES

(10/02/72)

Parameter	Minimum	Mean	Median	Maximum
Temperature (Cent.)	14.9	15.9	16.0	16.4
Dissolved oxygen (mg/l)	6.9	7.7	7.6	9.2
Conductivity (μmhos)	67	77	80	82
pH (units)	5.8	6.7	6.6	7.3
Alkalinity (mg/l)	15	18	19	22
Total P (mg/l)	0.015	0.087	0.083	0.152
Dissolved P (mg/l)	0.014	0.067	0.059	0.113
NO_2 + NO_3 (mg/l)	0.070	0.099	0.095	0.140
Ammonia (mg/l)	0.090	0.285	0.155	0.590

ALL SAMPLES

Secchi disc (inches)	30	41	36	72

B. Biological characteristics:

1. Phytoplankton* -

Sampling Date	Dominant Genera	Number per ml
10/02/72	1. Oscillatoria	1,608
	2. Flagellates	1,482
	3. Cryptomonas	377
	4. Anabaena	352
	5. Dinobryon	327
	Other genera	2,236
	Total	6,382

* The other phytoplankton samples were lost in transit.

2. Chlorophyll a -
(Because of instrumentation problems during the 1972 sampling, the following chlorophyll values may be in error by plus or minus 20 percent.)

Sampling Date	Station Number	Chlorophyll a (µg/l)
06/03/72	01	3.0
	02	5.5
	03	6.3
08/05/72	01	59.5
	02	47.3
	03	2.4
10/02/72	01	63.7
	02	49.0
	03	18.2

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.048	0.333	11.2
0.006 P	0.054	0.333	11.1
0.012 P	0.060	0.333	10.6
0.024 P	0.072	0.333	10.8
0.060 P	0.108	0.333	10.3
0.060 P + 10.0 N	0.108	10.333	70.7
10.0 N	0.048	10.333	28.2

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates a rather high level of potential primary productivity in Estes Lake at the time the sample was collected. Also, the lack of yield response to increments of orthophosphorus indicates the lake was nitrogen limited (note

that the only significant yield responses occurred with the addition of nitrogen alone or in combination with orthophosphorus).

The field data confirm the conclusion that Estes Lake was nitrogen limited; nitrogen to phosphorus ratios at all depths and sampling times were predominantly less than 14 to 1 (i.e., nitrogen limitation would be expected).

On the basis of assay and field data, it appears the available phosphorus level in Estes Lake would have to be reduced to about 0.022 mg/l to make phosphorus limiting (assuming no appreciable change in inorganic nitrogen concentrations).

D. Trophic Condition:

The results of the lake sampling and the algal assay indicate Estes Lake is eutrophic. Chlorophyll a values were high, Secchi disc transparencies were low, and nutrient levels were quite high for a water body with such a short retention time.

Survey limnologists noted that there were heavy algal blooms present during the August and October sampling periods. They described the appearance of Estes Lake as "poor".

Ciullo (1972), in his review of historical data on Estes Lake, cites a 1954 Maine Department of Inland Fisheries and Game report in which the lake was said to be relatively free of eutrophic con-

ditions. However, subsequent studies and reports, Ciullo's included, indicate the lake was exhibiting signs of eutrophication (frequent and heavy algal blooms, abundant growths of aquatic weeds, and depletion of dissolved oxygen in the deeper areas).

Estes Lake appears to have become eutrophic in the last 20 years.

V. NUTRIENT LOADINGS*
(See Appendix B for data)

For the determination of nutrient loadings, from September, 1972, through August, 1973, the Maine National Guard collected monthly near-surface grab samples at each of the tributary sites indicated on the map (page v), except for the high runoff months of April and May, when two samples were collected, and when cold weather prevented sampling one or more times at three of the sites.

Stream flow estimates were provided by the Maine District Office of the U.S. Geological Survey through an interagency agreement. However, these data indicate more water flowing into Estes Lake than flowing out (see Appendix A). Therefore, the runoff coefficient (cubic feet per second flow per square mile of drainage) from a near-by U.S.G.S. gaging station was used to estimate flows (cfs/mi^2 x drainage areas in mi^2) for each of the tributaries.

In this report, tributary loads were calculated using mean flows and mean concentrations. The loads for unsampled "minor tributaries & immediate drainage" ("ZZ" of U.S.G.S.) were calculated using ZZ flows and Middle Branch of the Mousam River concentrations at site C-1.

The operator of the Sanford Sewerage District treatment facilities provided monthly effluent samples and corresponding flow data for the determination of nutrient loads from this source.

---

* Based on sampling frequency and variations in concentrations, single tributary loadings for gaged sites are believed to be within ±16% of the true value 67% of the time and within ±32% of the true value 95% of the time.

A. Waste Sources:

1. Municipal -

Name	Pop. Served	Treatment	Mean Flow (mgd)	Receiving Water
Sanford	16,000	Stabiliza-tion Lagoons	4.0	Mousam River

2. Industrial - None known

B. Annual Total Phosphorus Loading -

1. Inputs -

Source	lbs P/ yr	% of total
a. Tributaries (non-point load) -		
Mousam River	4,870	14.7
Hay Brook	280	0.8
Middle Br., Mousam River	1,100	3.3
Littlefield River	1,520	4.6
b. Minor tributaries & immediate drainage (non-point load)* -	680	2.0
c. Municipal STP's -		
Sanford	24,700	74.3
d. Septic tanks** -	30	0.1
e. Industrial -		
None known	-	-
f. Direct Precipitation* -	60	0.2
Total	33,320	100.0

2. Outputs -

Lake outlet (Mousam River) 31,430

3. Net annual P accumulation - 1,810 lbs.

* Estimated; see Working Paper No. 1, "Survey Methods"
** Estimated 50 residences within 500 feet of Estes Lake.

C. Annual Total Nitrogen Loading -

1. Inputs -

Source	lbs N/ yr	% of total
a. Tributaries (non-point load) -		
Mousam River	114,100	30.0
Hay Brook	10,420	2.7
Middle Br., Mousam River	53,730	14.1
Littlefield River	65,440	17.2
b. Minor tributaries & immediate drainage (non-point load)* -	32,920	8.6
c. Municipal STP's -		
Sanford	99,650	26.1
d. Septic tanks** -	1,060	0.3
e. Industrial -		
None known	-	-
f. Direct precipitation* -	3,730	1.0
Total	381,050	100.0

2. Outputs -

Lake outlet (Mousam River) 426,420

3. Net annual N loss - 45,370 lbs.

* Estimated; see Working Paper No. 1, "Survey Methods"
** Estimated 50 residences within 500 feet of Estes Lake

D. Mean Annual Non-point Nutrient Export by Sub-drainage Area:

Tributary	lbs P/mi^2/yr	lbs N/mi^2/yr
Mousam River	96	2,259
Hay Brook	100	3,721
Middle Br., Mousam River	65	3,198
Littlefield River	62	2,660

E. Yearly Loading Rates:

In the following table, the existing phosphorus loading rates are compared to those proposed by Vollenweider (1973). Essentially, his "dangerous" rate is the rate at which the receiving waters would become eutrophic or remain eutrophic; his "permissible" rate is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic rate would be considered one between "dangerous" and permissible".

	Total Phosphorus		Total Nitrogen	
Units	Total	Accumulated	Total	Accumulated
lbs/acre/yr	85.9	4.7	984.6	loss
grams/m^2/yr	9.63	0.52	110.4	-

Vollenweider loading rates for phosphorus (g/m^2/yr) based on mean depth and mean hydraulic retention time for Estes Lake:

"Dangerous" (eutrophic rate)	1.92
"Permissible" (oligotrophic rate)	0.96

F. Nutrient Loading and Controllability:

During the Survey year, Estes Lake received a total phosphorus load at a rate far greater than that proposed by Vollenweider as "dangerous" (i.e., a eutrophic rate). Of this load, the Sanford

Sewerage District treatment facility contributed about 74%. Institution of 90% phosphorus removal at this source would reduce the total phosphorus loading to the lake by 67% (about 22,230 pounds per year) and would result in a loading rate of about 28 lbs/acre/yr or about 3 $g/m^2/yr$.

This loading rate, although still somewhat higher than a eutrophic rate, should result in a reduction in the incidence and severity of nuisance algal blooms and essentially restore the conditions that existed in Estes Lake before the Sanford facilities became operational in 1962.

Because of the very short hydraulic retention time, a new phosphorus equilibrium should become established shortly after phosphorus input has been reduced, particularly if the operation of the 20-foot-head dam would permit one or more drawdowns. The net effects of sediment consolidation, a new phosphorus equilibrium and a lowered phosphorus loading rate should be beneficial; aesthetic and recreational improvements should be expected.

It is noted that there was an apparent nitrogen loss from Estes Lake during the year of sampling. Although Survey data do not provide an explanation for this, there are several possibilities, including nitrogen fixation by bacteria and/or blue-green algae, resolubiliation of nitrogen from bottom sediments, and recharge with ground water of relatively high nitrogen content.

A similar loss of nitrogen has been observed in other Survey lakes: and Shagawa Lake in Minnesota, which has been intensively studied by the National Eutrophication Research Branch of EPA, has exhibited this phenomenon.

VI. LITERATURE REVIEWED

Anonymous, 1967. Estes Lake survey report. Dept. of Inland Fisheries & Game, Augusta.

Ciullo, Robert H., 1971. A report on a study of the Sanford Sewerage District stabilization pond system. MS, Biology Dept., Nasson College, Springvale.

_____. 1972. Final report on the water quality study program of Estes Lake and its tributaries, York County, Maine. MS, Biology Dept., Nasson College, Springvale.

Hinckley, William P., 1972. Personal communication (possible point sources contributing nutrients to Estes Lake; description of Sanford waste treatment facility). Dept. of Environmental Protection, Augusta.

Scott, Matthew, 1974. Personal communication (trophic condition of Estes Lake). Dept. of Environmental Protection, Augusta.

TRIBUTARY FLOW INFORMATION FOR MAINE 6/25/74

LAKE CODE 2304 ESTES LAKE

TOTAL DRAINAGE AREA OF LAKE 105.00

TRIBUTARY	SUB-DRAINAGE AREA	NORMALIZED FLOWS JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
2304A1	105.00	135.00	157.00	251.00	444.00	223.00	103.00	57.00	46.00	59.00	110.00	187.00	200.00	164.19
2304A3	50.50	91.00	80.00	149.00	190.00	140.00	69.00	34.00	29.00	50.00	45.00	75.00	92.00	87.13
2304B1	2.80	4.90	4.40	9.70	18.00	6.80	3.00	1.40	1.10	1.70	2.50	6.50	6.70	5.55
2304C1	16.80	26.00	24.00	58.00	104.00	46.00	22.00	9.60	6.70	10.00	15.00	37.00	35.00	32.05
2304D1	24.50	47.00	41.00	91.00	132.00	59.00	29.00	12.00	8.00	12.00	17.00	48.00	51.00	45.52
2304Z7	10.10	22.00	22.00	34.00	45.00	22.00	12.00	5.20	3.70	4.60	5.90	16.00	24.00	17.99

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 105.00
SUM OF SUB-DRAINAGE AREAS = 104.80
TOTAL FLOW IN = 2261.40
TOTAL FLOW OUT = 1974.00

MEAN MONTHLY FLOWS AND DAILY FLOWS

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
2304A1	9	72	58.00	16	75.00				
	10	72	97.00	14	92.00				
	11	72	276.00	4	162.00				
	12	72	287.00	3	296.00				
	1	73	267.00	7	194.00				
	2	73	293.00	3	664.00				
	3	73	431.00	4	179.00				
	4	73	560.00	7	764.00	21	286.00		
	5	73	435.00	5	334.00	19	502.00		
	6	73	187.00	2	330.00				
	7	73	117.00	14	20.00				
	8	73	76.00	12	20.00				
2304A3	9	72	58.00	16	55.00				
	10	72	45.00	14	49.00				
	11	72	127.00	4	82.00				
	12	72	165.00	3	208.00				
	1	73	157.00	7	107.00				
	2	73	228.00	3	484.00				
	3	73	440.00	4	90.00				
	4	73	217.00	7	265.00	21	155.00		
	5	73	231.00	5	193.00	19	258.00		
	6	73	142.00	2	196.00	10	107.00		
	7	73	162.00	14	122.00				
	8	73	94.00	12	93.00				

LAKE CODE 2304 ESTES LAKE

MEAN MONTHLY FLOWS AND DAILY FLOWS

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
230401	9	72	2.30	16	2.10				
	10	72	2.40	14	2.80				
	11	72	11.05	4	7.30				
	12	72	12.00	3	15.00				
	1	73	8.30	7	5.50				
	2	73	12.00	3	25.00				
	3	73	25.00	4	6.50				
	4	73	20.00	7	24.00	21	15.00		
	5	73	12.00	5	9.80	19	14.00		
	6	73	6.50	2	9.10				
	7	73	8.30	14	6.60				
	8	73	5.90	12	5.80				
230402	9	72	14.00	16	13.00				
	10	72	15.00	14	17.00				
	11	72	51.00	4	40.00				
	12	72	62.00	3	78.00				
	1	73	44.00	7	30.00				
	2	73	63.00	3	130.00				
	3	73	130.00	4	34.00				
	4	73	115.30	7	136.00	21	89.00		
	5	73	81.00	5	66.00	19	92.00		
	6	73	48.00	2	47.00				
	7	73	61.00	14	45.00				
	8	73	36.00	12	36.00				
230403	9	72	17.00	16	15.00				
	10	72	16.00	14	18.00				
	11	72	79.00	4	52.00				
	12	72	90.00	3	113.00				
	1	73	80.00	7	54.00				
	2	73	108.00	3	224.00				
	3	73	237.30	4	62.00				
	4	73	147.00	7	174.00	21	113.00		
	5	73	104.30	5	85.30	19	118.00		
	6	73	63.00	2	48.00				
	7	73	76.00	14	56.00				
	8	73	43.00	12	43.00				
230477	9	72	6.30						
	10	72	5.70						
	11	72	26.00						
	12	72	42.00						
	1	73	17.00						
	2	73	58.00						
	3	73	88.00						
	4	73	50.00						
	5	73	39.00						
	6	73	26.00						
	7	73	33.00						
	8	73	20.00						

APPENDIX B

PHYSICAL and CHEMICAL DATA

K - Value is less than indicated
J - Value known to be in error

STORET RETRIEVAL DATE 74/06/25

230401
43 25 24.0 070 40 06.0
ESTES LAKE
23007 MAINE

11EPALES 2111202
3 0007 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/03	12 30	0000	20.6	7.2	42	60	6.70	10K	0.090	0.170	0.094	0.050
	12 30	0006	19.6	7.2		60	6.70	10K	0.060	0.130	0.100	0.045
72/08/05	14 40	0000			30	90	7.00	13	0.050	0.100	0.129	0.070
	14 40	0001	23.1	9.0		85	6.90	12	0.060	0.130	0.132	0.076
	14 40	0005	22.9	8.8		85	6.90	11	0.070	0.130	0.140	0.077
72/10/02	07 20	0000			32	80	7.25	18	0.090	0.140	0.085	0.061
	07 20	0004	16.4	9.2		80	7.10	15	0.090	0.140	0.068	0.057
	07 20	0015	16.3	6.9		67	6.95	16	0.100	0.170	0.082	0.057

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/03	12 30	0000	3.0J
72/08/05	14 40	0000	59.5J
72/10/02	07 20	0000	63.7J

STORET RETRIEVAL DATE 74/06/25

230402
43 25 42.0 070 41 00.0
ESTES LAKE
23 MAINE

11EPALES
3

2111202
0016 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/03	12 50	0000	19.6	5.9	36	60	6.60	10K	0.080	0.200	0.088	0.039
	12 50	0006	18.0	5.3		60	6.50	10K	0.080	0.200	0.059	0.025
	12 50	0012	16.5	3.8		55	6.30	10K	0.070	0.160	0.062	0.026
	12 50	0016	14.6	2.2		60	6.20	10K	0.060	0.310	0.174	0.066
72/08/05	14 55	0000			36	85	6.90	14	0.080	0.110	0.138	0.077
	14 55	0004	22.7	8.0		90	6.80	15	0.080	0.210	0.147	0.091
	14 55	0007	22.6	8.0		95	6.70	15	0.100	0.260	0.184	0.102
72/10/02	07 45	0000			36	80	6.60	22	0.110	0.540	0.143	0.108
	07 45	0004	16.0	7.6		80	6.55	19	0.100	0.520	0.136	0.110
	07 45	0008	15.9	7.8		82	6.65	19	0.140	0.590	0.152	0.113

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/03	12 50	0000	5.5J
72/08/05	14 55	0000	47.3J
72/10/02	07 45	0000	49.0J

STORET RETRIEVAL DATE 74/06/25

230403
43 27 30.0 070 42 12.0
ESTES LAKE
23 MAINE

11EPALES
3

2111202
0006 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/03	14 00	0000	21.9	7.6	48	40	6.50	10K	0.110	0.160	0.032	0.012
72/08/05	15 15	0000			72	60	6.40	10K	0.100	0.070	0.026	0.016
	15 15	0004	21.6	7.4		65	6.50	11	0.090	0.110	0.021	0.013
72/10/02	08 00	0000			38	70	6.50	20	0.090	0.090	0.016	0.015
	08 00	0004	14.9	7.2		75	5.80	17	0.070	0.090	0.015	0.014

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/03	14 00	0000	6.3J
72/08/05	15 15	0000	2.4J
72/10/02	08 00	0000	18.2J

APPENDIX C

TRIBUTARY and WASTEWATER TREATMENT PLANT DATA

K - Value is less than indicated
J - Value known to be in error

STORET RETRIEVAL DATE 74/06/25

2304A1 LS2304A1
43 25 00.0 070 39 30.0
MOUSAM RIVER
23007 15 KENNEBUNK
0/ESTES LAKE
WITCHERS MILL RD NE OF SANFORD CITY
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/09/16	12	40	0.117	1.600	0.105	0.072	0.198
72/10/14	11	30	0.180	0.950	0.315	0.048	0.120
72/11/04	11	45	0.130	2.100	0.380	0.050	0.130
72/12/03	11	00	0.110	0.600	0.220	0.039	0.069
73/01/07	13	00	0.147	0.730	0.230	0.046	0.072
73/02/03			0.150	1.260	0.350	0.054	0.080
73/03/04					0.220	0.023	0.055
73/04/07			0.105	0.460	0.105	0.019	0.050
73/04/21			0.110	0.440	0.115	0.025	0.045
73/05/05			0.105	0.780	0.060	0.019	0.065
73/05/19			0.081	0.500	0.060	0.022	0.070
73/06/02			0.071	1.980	0.097	0.026	0.065
73/07/14			0.168	1.260	0.132	0.031	0.085
73/08/12			0.480	1.260	0.470	0.077	0.150

STORET RETRIEVAL DATE 74/06/25

2304A2 LS2304A2
43 25 00.0 070 44 30.0
MOUSAM RIVER
23 15 KENNEBUNK
I/ESTES LAKE
ST HWY 4 BRDG ABOV SANFORD STP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/09/16	12 20		0.076	0.375	0.091	0.007	0.026
72/10/14	13 15		0.130	0.550	0.170	0.005K	0.029
72/11/04	12 45		0.078	1.200	0.126	0.006	0.033
72/12/03	09 50		0.132	0.340	0.072	0.005K	0.018
73/01/07	10 15		0.105	0.710	0.046	0.005K	0.011
73/03/04			0.170	0.380	0.048	0.007	0.010
73/04/07			0.132	0.450	0.075	0.019	0.050
73/04/21			0.120	0.370	0.052	0.015	0.065
73/05/05			0.091	0.580	0.050	0.005K	0.020
73/05/19			0.068	0.400	0.048	0.007	0.025
73/06/02			0.060	0.500	0.060	0.015	0.030
73/07/14			0.147	0.990	0.130	0.006	0.030

STORET RETRIEVAL DATE 74/06/25

2304A3 LS2304A3
43 25 30.0 070 41 00.0
MOUSAM RIVER
23 15 KENNEBUNK
I/ESTES LAKE
MOUSE LANE BRDG BELOW SANFORD STP
11ES ALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/09/16	13	00	0.034	2.050	0.048	0.069	0.200
72/10/14	12	15	0.155	1.750	1.260	0.231	0.310
72/11/04	12	15	0.104	1.260	0.700	0.118	0.200
72/12/03	10	10	0.132	1.150	0.470	0.089	0.141
73/03/04			0.160	0.880	0.460	0.088	0.135
73/04/07			0.138	1.050	0.240	0.042	0.090
73/04/21			0.120	0.640	0.231	0.042	0.110
73/05/05			0.099	1.180	0.176	0.050	0.110
73/05/19			0.092	0.880	0.176	0.056	0.110
73/06/02			0.079	1.050	0.198	0.061	0.120
73/06/10	08	30	0.092	0.190	0.008	0.005K	0.015
73/07/14			0.017	3.100	0.130	0.021	0.188
73/08/12			0.010K	3.700	0.042	0.357	0.730

STORET RETRIEVAL DATE 74/06/25

230481 LS230481
43 26 30.0 070 44 00.0
HAY BROOK
23 15 KENNEBUNK
T/ESTES LAKE
ST HWY 4 BRDG SSW OF ALFRED
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/09/16	13 15		0.100	1.000	0.139	0.022	0.039
72/10/14	10 50		0.090	0.950	0.131	0.007	0.019
72/11/04	11 15		0.032	0.600	0.044	0.007	0.019
72/12/03	10 30		0.115	2.400	0.050	0.005K	0.009
73/01/07	09 30		0.170	0.540	0.058	0.005K	0.010
73/03/04			0.280	0.690	0.066	0.012	0.015
73/04/07			0.089	0.420	0.022	0.009	0.015
73/04/21			0.073	0.310	0.031	0.005K	0.010
73/05/05			0.078	2.400	0.078	0.007	0.020
73/05/19			0.066	0.460	0.031	0.010	0.025
73/06/02			0.046	1.540	0.050	0.017	0.030
73/07/14			0.066	0.900	0.063	0.018	0.065
73/08/12			0.026	1.200	0.100	0.042	0.110

STORET RETRIEVAL DATE 74/06/25

2304C1 LS2304C1
43 28 00.0 070 42 30.0
MIDDLE BR MOUSAM RIVER
23 15 KENNEBUNK
I/ESTES LAKE
BRDG W OF ALFRED MILLS BELO ALFRED STPS
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/09/16	14	00	0.110	1.600	0.176	0.025	0.060
72/10/14	09	45	0.208	0.750	0.138	0.007	0.024
72/11/04	10	15	0.058	0.840	0.087	0.005K	0.021
72/12/03	09	30	0.078	0.250	0.011	0.005K	0.008
73/01/07	11	45	0.054	0.580	0.018	0.005K	0.008
73/02/03			0.082	0.400	0.028	0.011	0.015
73/03/04			0.100	0.365	0.022	0.005K	0.010
73/04/07			0.054	0.250	0.032	0.005K	0.010
73/04/21			0.048	0.200	0.026	0.005K	0.005K
73/05/05			0.088	0.290	0.021	0.005K	0.010
73/05/19			0.086		0.080	0.007	0.017
73/06/02			0.084	2.520	0.083	0.007	0.020
73/07/14			0.360	2.200	0.150	0.009	0.035
73/09/12			0.300	0.630	0.050	0.021	0.035

STORET RETRIEVAL DATE 74/06/25

2304C2 LS2304C2
43 28 00.0 070 43 30.0
MIDDLE BR MOUSAM RIVER
23 15 KENNEBUNK
I/ESTES LAKE
ST HWY 4 BRDG ABOV ALFRED STPS
11FPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/09/16	13 30		0.164	0.537	0.180	0.024	0.028
72/10/14	10 15		0.117	0.800	0.170	0.008	0.026
72/11/04	10 45		0.034	0.960	0.052	0.005K	0.019
72/12/03	12 00		0.046	0.270	0.009	0.005K	0.008
73/02/03			0.066	0.295	0.023	0.008	0.025
73/03/04			0.198	0.290	0.027	0.005K	0.010
73/04/07			0.026	0.160	0.005K	0.005K	0.005K
73/04/21			0.022	0.360	0.018	0.005K	0.010
73/05/05			0.034	0.290	0.017	0.005K	0.015
73/05/19			0.030	0.310	0.018	0.006	0.015
73/06/02			0.024	1.500	0.042	0.013	0.020
73/07/14			0.105	0.650	0.036	0.010	0.040
73/08/12			0.069	0.690	0.030	0.016	0.035

STORET RETRIEVAL DATE 74/06/25

2304D1 LS2304D1
43 28 00.0 070 42 00.0
LITTLEFIELD RIVER
23 15 KENNEBUNK
T/ESTES LAKE
BRDG IN ALFRED MILLS
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/09/16	13 40		0.099	0.500	0.105	0.008	0.023
72/10/14	09 15		0.045	0.850	0.066	0.005K	0.017
72/11/04	09 45		0.055	0.690	0.110	0.005K	0.020
72/12/03	11 30		0.040	0.560	0.022	0.005K	0.012
73/01/07	11 00		0.170	0.300	0.034	0.005K	0.012
73/02/03			0.200	0.460	0.042	0.008	0.010
73/03/04			0.252	0.330	0.040	0.007	0.015
73/04/07			0.058	1.200	0.019	0.005K	0.010
73/04/21			0.054	0.300	0.016	0.005K	0.010
73/05/05			0.044	0.365	0.015	0.005K	0.017
73/05/19			0.044	0.670	0.050	0.005K	0.020
73/06/02			0.052	1.300	0.044	0.005K	0.030
73/07/14			0.050	1.890	0.138	0.006	0.035
73/08/12			0.018	0.560	0.033	0.010	0.030

STORET RETRIEVAL DATE 74/06/25

230450 P0230450 P014800
43 24 30.0 070 44 00.0
SANFORD
23007 15 KENNEBUNK
T/ESTES LAKE
MOUSAM RIVER
11EPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/01/15	10 00		0.010K	10.000	5.350	1.890	2.300	3.090	4.000
73/02/14	10 00		0.115	9.100	5.800	1.400	2.100	4.000	4.000
73/03/13	09 30		0.065	8.700	5.500	1.470	1.900	5.190	4.000
73/04/19	10 10		0.105	7.200	2.300	0.820	1.530	3.400	3.700
73/05/16	09 45		0.065	6.100	3.200	1.200	1.600	4.990	4.000
73/06/14	10 50		0.044	8.200	4.620	1.500	2.100	5.500	4.000
73/07/17	10 30		0.044	7.800	3.440	1.700	2.300	5.600	4.000
73/08/14	09 30		0.044	7.100	2.300	1.700	2.200	5.000	4.600
73/09/07	09 00		0.010K	7.600	2.260	1.840	2.300	4.600	4.000
73/10/10	09 30		0.160	6.700	4.100	2.000	2.350	3.250	3.500
73/11/13	09 45		0.110	8.300	5.200	2.000	2.000	3.270	3.500
73/12/04	09 45		0.190	7.300	5.100	1.890	2.300	3.500	3.500